# Interconnection

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# Agenda

- What is interconnection?
- Background
- Small wind interconnection
- Large wind interconnection

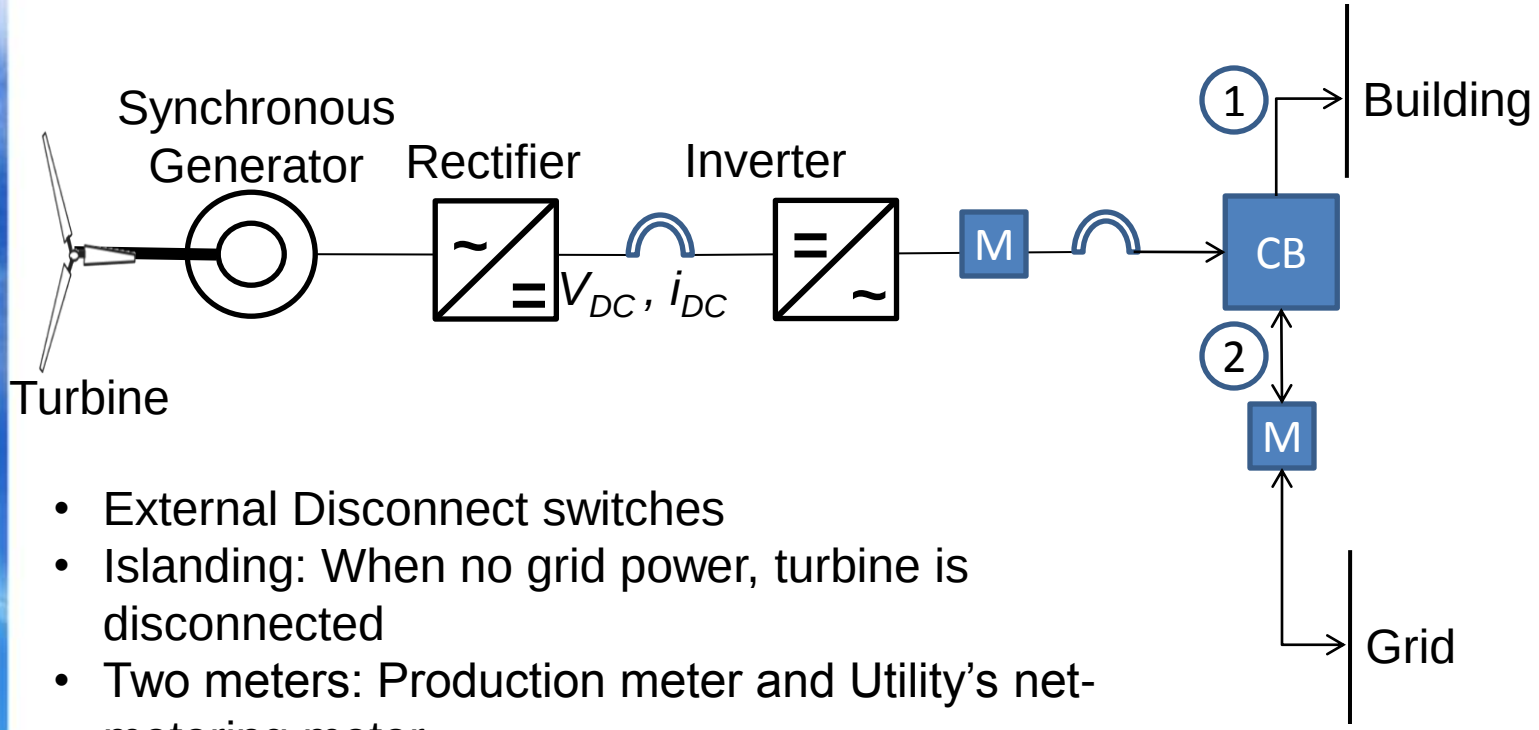
# What is interconnection?

- Delivering power from a generation facility to the grid
- Legal framework:
  - Utilities are required to provide to independent power producers the same transmission service that is provided to their own generators. The service must be provided through nondiscriminatory open access tariffs.

# Levels of Interconnection

- Small wind
- Community wind
- Large wind

# Small Wind Interconnection



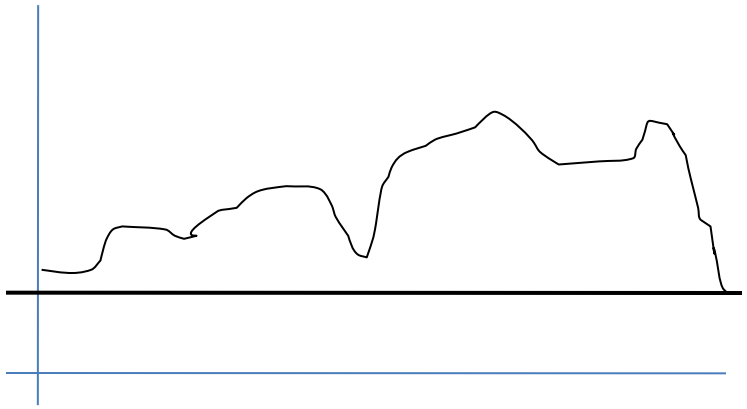

- External Disconnect switches
- Islanding: When no grid power, turbine is disconnected
- Two meters: Production meter and Utility's net-metering meter

- Fill out a form with utility.
- Type of generator
- UL certified inverter
- Certified disconnect switches

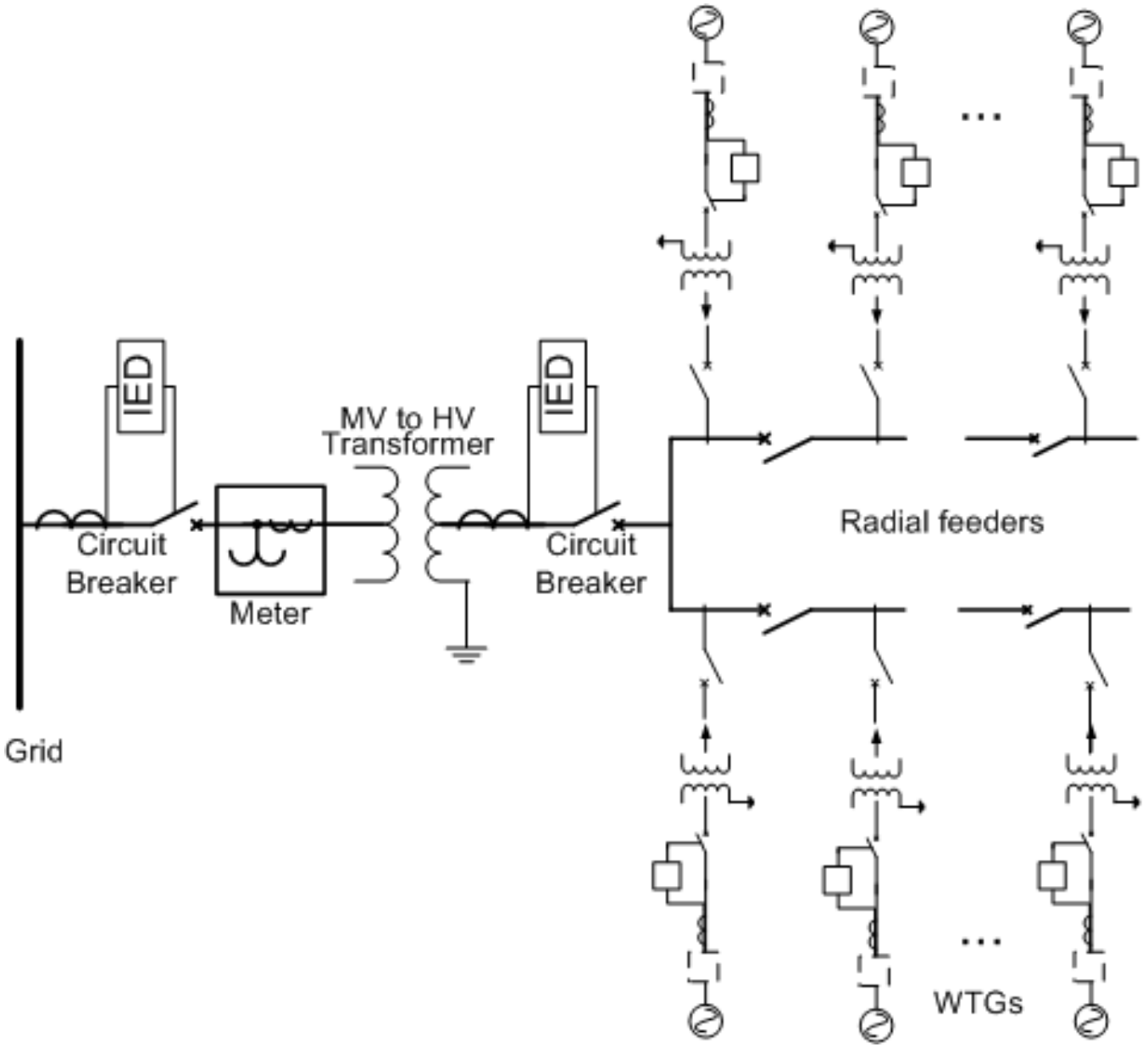
- Lightening protection

# Community & Large Wind Interconnection

- Background:
  - Wind is an intermittent resource
  - Base load generators & Spinning reserves
- How is electrical energy delivered to the grid?
  - Correct voltage
  - Correct frequency
  - Correct phase



# Interconnection Topology



# Community & Large Wind Interconnection

- Regional transmission operator (RTO)
  - Coordinates transmission, generation & distribution
  - PJM is RTO for DE, MD, NJ, OH, PA, VA, WV
- Large Generator Interconnection Request (LGIR) for 20MW or more
- Small Generator Interconnection Request (SGIR) for less than 20MW with a request for energy resource service

# Three step process

- Step 1: Feasibility Study
  - Check if the system can accept power injection at the interconnect point
  - Provide high level cost estimates for interconnection
  - Power flow and short circuit analysis.
  - Deposit of $10,000 is required
  - 45 days

# Three step process

- Step 2: System Impact Study
  - Detailed transmission planning study-- Impact of the proposed wind farm on existing transmission, generation and customers
  - Impact on short circuit power, dynamic and stability issues, protection systems, safety and reliability of transmission, and others
  - Written report on improvements to the transmission system, and estimated cost
  - Deposit of $50,000
  - 90 days

# Three step process

- Step 3 Facility Study
  - Detailed engineering study to design the interconnection substation and transmission, and to provide estimates for the cost and time to implement the upgrades
  - Delineate responsibilities of the wind farm developer and the local transmission company to upgrade transmission
  - Performed by local utility for the RTO
  - Deposit of $100,000.
  - 90 days or 180 days depending on accuracy of cost estimates requested

# Grid Upgrades for Large Wind Projects

- Ampacity is not sufficient
  - New conductors
- Weak grid:
  - Low power factor
- New substations
- New electrical equipment and protection gear